



Annual Reports :: Year 6 :: Pennsylvania State University

Project Report: Geochemical Record of the Early Terrestrial Environment

Project Investigators: | *Rosemary Capo , Brian Stewart*

Project Progress

We have focused much of our work on understanding the evolution of ancient soil profiles (paleosols), both syn- and post-pedogenic processes, and their record of Earth's early atmosphere and climate. We are using radiogenic isotopes as tools for geochronologic and provenance information. Our primary work over the past year has been on the following:

1. The Paleoproterozoic Hakkalampi paleosol, Finland. This unconformity on granodiorite parent material provides the opportunity to examine soil development under a variety of conditions, and at a critical time in Earth's atmospheric history. Isotopic analyses by Ph.D. student Sherry Stafford on two profiles suggests that pedogenic rare Earth element (REE) fractionation took place at about 2.35 Ga ago, and that the rubidium-strontium (Rb-Sr) system records metamorphism around 1.8 Ga ago. Work is nearly complete on a manuscript describing our results (Stafford et al., in 2004).
2. The Archean Steep Rock paleosol, Canada. Sherry Stafford has shown that the samarium-neodymium (Sm-Nd) systematics in this profile yield a relatively precise age of 3.0 Ga, and document the preservation of Archean pedogenic REE fractionation. We are using the results from the Steep Rock profile to develop a model for Sm-Nd evolution in paleosols, with a manuscript near submission (Stewart et al., 2004).

In addition to the above studies, we are continuing our investigations of iron isotope studies of sedimentary pyrite with Penn State Astrobiology Research Center (PSARC) investigator Brian Stewart. A portion of this investigation involves NSF-supported experimental determination of Fe isotope fractionation associated with pyrite oxidation, in collaboration with Dr. David Dzombak of Carnegie Mellon University. We are focusing our initial studies on well-characterized pyrite associated with Paleozoic coal and shale units, and will ultimately extend our investigation to Precambrian sulfides.

Highlights

- Determining the age of soil formation in ancient unconformities has always been a significant challenge. Application of the combined Rb–Sr and Sm–Nd geochronologic systems to Precambrian paleosols has allowed us to obtain timing information on both pedogenic and post–pedogenic episodes in some cases.

Roadmap Objectives

- **Objective No. 4.1:** Earth's early biosphere
- **Objective No. 6.1:** Environmental changes and the cycling of elements by the biota, communities, and ecosystems